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MISCELLANEOUS JOURNAL.

Some observations and experiments on the apparatus called the 'American Water Burner.'

Much attention has recently been excited by an apparatus called the 'American Water Burner.' This apparatus is the invention of Mr. Morey, of New Hampshire, who, as we are informed in a letter from John L. Sullivan, Esq. dated, Boston, Aug. 14, 1818, 'very early in life evinced his ingenuity in the construction of several steam boats, in one of which, as early as 1790 or 91, he demonstrated to Chancellor Livingston at New York the practicability of applying steam to the purpose of propelling vessels.' Mr. Morey has devoted much time to improving steam engines, and is the inventor of the 'revolving steam engine.' About twelve months since he communicated his discovery 'of a method of burning water to Mr Sullivan, who had long known him to be generally acquainted with chemical science, and therefore entered into his subject with some confidence.' These gentlemen after making many experiments and employing various combustible substances, as tar, rosin, oil, &c. to mix with the steam, have brought this apparatus to its present state of perfection. The construction of this machine is very simple; by means of it, tar is intimately mixed with steam or vapour of water, and made to issue, with a force proportional to the pressure of the steam, from a small orifice, like that in the jet of a blow-pipe, and is there fired. The flame, although the combustible substances issue from so small an orifice, is as large as that of a common smith's forge, and is unaccompanied with smoke; when this flame is directed against the bricks in the back of a fire place, they soon become heated to redness; if iron or steel filings be thrown into the flame, they burn with a sparkling brilliancy, similar to iron wire in oxygen gas. Some phenomena of this kind have led to the belief, that a new principle, hitherto uninvestigated, was concerned in their production; yet, every one acquainted with chemistry will at once conceive of the various changes produced by the action of this instrument, and will also recall to mind many analogous phenomena.

A few experiments have been made to ascertain the effect of steam on burning bodies, and to learn whether it probably suffered decomposition when issuing mixed with tar from the jet of the 'Water Burner.'

If a jet of steam, issuing from a small aperture, be thrown upon burning charcoal, its brightness is increased, if it be held at the distance of four or five inches from the pipe through which the steam passes; but if it be held nearer, the coal is extinguished, a circular black spot first appearing where the steam is thrown upon it. The steam does not appear to be decomposed in this experiment; the increased brightness of the coal is probably occasioned by a current of atmospheric air produced by the steam.

If the wick of a common oil lamp be raised so as to give off large columns of smoke, and a jet of steam be thrown into the flame, its brightness is a little increased, and no smoke is thrown off.

If spirits of turpentine be made to burn on a wick, the light produced is dull and reddish, and a large quantity of thick smoke is given off; but if a jet of steam be thrown into the flame, its brightness is much increased, and if the experiment be carefully conducted, the smoke entirely disappears.

If vapour of spirits of turpentine be made to issue from a small orifice and inflamed, it burns, giving off large quantities of smoke; but if a jet of steam be made to unite with the vapour, the smoke entirely disappears. The same effect takes place, if the vapour of spirits of turpentine and of water be made to issue together from the same orifice; hence the disappearing of the smoke cannot be supposed to depend on a current of atmospheric air.

If the flame of a spirit lamp be brought in contact with a jet of steam, it disappears and is extinguished at the points of contact, precisely as when exposed to strong blasts of air.

Masses of iron of various sizes and heated to various degrees from redness to bright whiteness were exposed to a jet of steam; no flame appeared, as was expected, but the iron was more rapidly oxidated where the steam came in contact with it than in other parts. It is probable, if the water suffered decomposition in this experiment, and if the hydrogen was inflamed, its flame might not be observed, when contrasted with the heated iron, a body so much more luminous.

It was attempted to ascertain the relative quantities of carbonic acid, produced by the flame of spirits of turpentine both with, and without steam. The vapour of spirits of turpentine was made to issue through a small orifice and inflamed; a bottle of the capacity of two pints was inverted over the flame and held there until it was extinguished. The flame of the vapour of turpentine alone soon disappeared, and a large quantity of carbon was deposited on the interior of the vessel; after the flame was extinguished a portion of the air remaining in the bottle was immediately examined by introducing it into Hope's eudiometer and agitating it with lime water, forty-five parts after agitation became forty-four, and the lime water was rendered turbid; but the flame, when aided by a jet of steam was not so soon extinguished, as in the last instance, nor was there much carbon deposited on the interior of the vessel, but the quantity of carbonic acid produced was greater; forty-five parts were diminished to forty-three; hence twice as much carbonic acid was produced by the aid of the steam, as without it; the residual air, when steam was employed, contained 4.444 per cent. carbonic acid; when not employed, 2.222. These experiments were repeated a number of times with the same results. An experiment was made to ascertain the relative heating powers of the flames when aided by steam, compared with flames of the same substances without steam; but the results were not satisfactory, as flames of the same size could not be produced.

The experiments above detailed, though not susceptible of much precision, are sufficient to show that steam is decomposed when thrown into flames where carbonaceous matter is evolved; and that it is decomposed when issuing mixed with tar from the jet of the 'Water Burner;' and that the quantity of heat is on the whole increased, by the combustion of a portion of carbon which would otherwise escape under the form of smoke.

It has been stated by many persons, that no increase of temperature, and consequently no advantage, could be derived from the supposed decomposition of water, because as much heat would be absorbed during the decomposition, as would be developed by the recomposition of water; this objection is very plausible; and is founded on the hypothesis, that the caloric in combustion arises from a diminution of capacity for heat, in the bodies entering into union; this objection disregards one remarkable phenomenon presented by this flame, viz. the absence of smoke.

Let us for a moment examine this hypothesis of the origin of heat in combustion, and learn whether mere change of capacity can afford an adequate explanation. If the researches of Delaroche and Berard, on the specific heat of gasses,* be entitled to confidence, the heat evolved during combustion cannot arise from a diminution in the capacities of bodies entering into combination. The capacity for heat, according to these philosophers, of oxygen gas is 0.2361, and of carbonic acid 0.2210; oxygen gas possesses, therefore, about $\frac{15}{1000}$ higher capacity than carbonic acid gas. Now, according to Lavoisier, the heat evolved by the combustion of one pound of charcoal is sufficient to melt 96.5 pounds of ice, which, while passing to the state of water, renders latent no less than 13510° of heat.† All this heat then must arise from a diminished capacity, oxygen gas, of which about 2.63 pounds are consumed with one pound of charcoal,‡ so that each pound of oxygen furnishes no less than 5981°; here a change of capacity which does not amount to $\frac{1}{16}$ of the whole, occasions an evolution of heat, amounting to 5981°; if this be the fact, the absolute heat of oxygen gas should be 95896°, which very much exceeds the estimate of any philosopher.

There is no doubt that heat is extricated during the formation of red oxide of lead; yet this substance has a capacity greater than the mean of its constituents; the intense temperature produced by the combustion of oxygen and hydrogen gasses, in the apparatus invented by our countryman, Dr. Hare, is well known to men of science, yet the heat here evolved must have some other origin than change of capacity of the two gasses, because the capacity of water for heat is much greater than its constituents, and consequently on the hypothesis under examination, *cold* ought to be produced during their union.

These instances have been brought forward to show that we must seek some other cause of the temperature produced by the water-burner, than mere change of capacity; it may be the evolution of *chymical heat.*

There are many facts in chymistry as difficult to explain as the high temperature produced by the water-burner, and with which this should be classed. The temperature of flames of candles and lamps, is doubtless as high as that produced by this instrument; for not only will steel and iron filings burn vividly when projected into them, but a fine filament of platinum may be melted in them, and if the flame be urged by a blow-pipe, comparatively large platina wire may be readily fused, as any one may satisfy himself by experiment.* The flame of hydrogen fuses platina† and the flame of cyanogen gas, which contains gasseous carbon, fuses a larger wire than a flame of hydrogen of an equal size;‡ and it is not improbable, that nascent carbon will produce a higher temperature than solid charcoal. These facts prove that the temperature of flame is very high. The flame of the Water Burner will no doubt melt small pieces of platina, although it might be difficult for it to bring a cubic foot or even a cubic inch of that metal into fusion.

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* See their Memoir, which gained the prize proposed by the French Institute, translated in Thomson's Annals, vol. 2, p. 134.

† This calculation is founded on the supposition, that 140° is the latent heat of water. This number is generally adopted by philosophers in preference 135°, obtained by Cavendish. See Wollaston, Phil. Trans. 1813. Henry's Chem. Thomson.

‡ Calculated on Davy's Numbers for oxygen and carbon. Elem. Chem. Philosophy.

Another reason why this apparatus apparently produces so high a temperature, is, that its flame is constantly acting like a flame urged by a blow-pipe, and a large quantity of burning matter is brought into contact with a given body in a given time; hence the bricks in the back of a fire-place are rapidly heated; and hence also, substances which are merely heated to whiteness by a flame, are easily fused when that flame is urged by a blow-pipe.

There is no method of determining the absolute temperature of bodies. Sir H. Davy has found that one volume of cyanogen detonated in a tube with two of oxygen, indicated a temperature of 5000° Fahrenheit; and he considers the real temperature to be much higher, since the cooling agency of the tube must have diminished the effect. Small quantities of matter heated to whiteness, hardly give the sensation of warmth to the hand, while larger quantities of comparatively low temperature burn intensely; phosphorus, when exposed to the air, is always luminous; 'for each particle of acid formed, must, there is every reason to believe, be white hot;' yet so few of these particles exist in a given space, that they scarcely raise the temperature of a body exposed to them; but when phosphorus is rapidly burnt and many particles of acid formed in a small space, the temperature produced is very intense.

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* In turning the delicate steel parts of philosophical instruments, fine, thin shavings are thrown off, which form a kind of *metallic wool;* these may be burnt in the flame of a candle, even when the quantity exceeds the bulk of a cubic inch.

† Davy, Phil. Trans. 1817, p. 47. ‡ Ibid. p. 67.

The effect produced by the water-burner is increased by the decomposition of steam; but if the steam was not decomposed, its presence would but slightly diminish the power of the instrument; because at high temperatures gasses not concerned in combustion, and vapours which require a high temperature for their production, have less effect in preventing combustion than gasses at the ordinary temperature of the air; because their cooling agency is diminished. This is remarkably the case with steam. The least of all explosive mixtures, carburetted hydrogen and air, was found by Sir H. Davy to require $\frac{1}{3}$ of steam to prevent explosion, whereas $\frac{1}{5}$ of azote produced that effect.

The operation of the water-burner, then appears to be simply this,—tar, minutely divided and intimately mixed with steam, is inflamed; the heat of the flame, aided by the affinity for oxygen of that portion of carbon, which would otherwise pass off in smoke, decomposes the water, and the carbon and oxygen unite; the hydrogen of the water, and probably of the tar, expand on all sides (and hence the flame is very large) to meet the atmospheric oxygen, water is recomposed, and passes off in steam; a degree of heat is produced, no doubt, greater than that which is produced by the combustion of the tar alone, and this heat is equal to that evolved by the combustion of a quantity of carbon, which would otherwise form smoke.

With regard to the light emitted by this flame, we can only refer to the general fact, that when solid matter is evolved and ignited in a flame, the light is very intense, and on the contrary, where gaseous matter is the product of combustion, the light is feeble. Hydrogen, when inflamed, gives little light, carburetted hydrogen more, and bicarburetted hydrogen produces a flame of still greater brilliancy. The flame of a spirit of wine lamp gives light of low intensity, but when a coil of platina wire is held in it, the illuminating power is greatly augmented.

It does not appear that the phenomena presented by this instrument are new; the invention is highly ingenious, and will doubtless be found very useful in steam boat navigation, where it is already applied by Mr. Sullivan. Probably a saving of heat would be produced by condensing the products of this combustion, which might be effected to a certain degree, by an apparatus of simple construction.